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It is almost needless to mention, that the same plan of construction may be extended to a hydrometer for fluids lighter than water; such an instrument may be advantageously employed for determining the specific gravity of ammoniacal solutions, of sulphuric æther, &c. and will be found to give results sufficiently near for commercial purposes, if temperature be correctly taken into the account; but for alcohol I cannot do better than recommend the use of Stokes's Hydrometer, as improved by Mr. Ainger.

The above method, as has been premised, depends upon the stem of the instrument being truly cylindrical; but should the stem be otherwise, a greater number of points must of consequence be taken, and, of course, a greater number of fluids will be required; not less than seventeen ought to be used under these circumstances; the interpolations may then be made as above.

N° V.

OXY-HYDROGEN BLOW-PIPE.

The GOLD ISIS MEDAL *of the Society was this Session presented to* GOLDSWORTHY GURNEY, *Esq. Surgeon, for his* OXY-HYDROGEN BLOW-PIPE, *which has been placed in the Society's Repository.*

THE investigations and discoveries of sir H. Davy, on the nature of flame, and the successful application of them in the construction of the miner's safe-lamp, demonstrated that the flame produced from the detonation of explosive mixtures of carburetted hydrogen and oxygen is not capable of passing through the small interstices of iron wire gauze. It was hence concluded that a similar barrier interposed between two portions of a mixture of oxygen and hydrogen in the proportions necessary to produce water, would prevent the inflammation of one portion from being communicated to the other, and thus would render safe the use of that most powerful instrument of combustion, the oxy-hydrogen blow-pipe. Accidents, however, occasionally occurred, notwithstanding the interposition of the wire gauze, and this circumstance induced Mr. Gurney to institute experiments, with the view of ascertaining the cause of these accidents, and, if possible, of preventing them. Accordingly, he first provided a jet, consisting of a cylinder of copper, three inches long, one inch in diameter, and perforated by a hole one-eightieth of an inch in diameter, in which the difference between the areas of the section of the solid metal and of the aperture, gave to the experiment nearly all the chance of success which it could derive from such means. Through this tube, however, the flame repeatedly passed, each time exploding the reservoir. He next reduced the size and increased the number of the apertures, by casting plaster of Paris round twenty lengths of the finest steel harpsichord wire, which were afterwards drawn out, and a brass cap fitted on, uniting all the gas passing through the apertures into one common jet. This succeeded no better, nor was any security obtained by increasing the length of the tube from three to six inches and casting lead round the wires instead of plaster.

After trying, without success, tubes of all descriptions, and many modifications of wire gauze, Mr. Gurney observed, that when the mixed gas was issuing from the reservoir in a state of great compression, it would not burn at the jet, and he further noticed that the explosions in the former experiments had all taken place when the pressure in the reservoir had become considerably lessened. It appeared, therefore, that though the gas under diminished pressure will pass in a state of ignition through very small tubes, yet that under stronger pressure it will not ignite when actually passing through the flame of a taper, and, of consequence, that its combustion is in a greater degree affected by the mechanical force with which it is impelled, than by the size of the current, or of the tube through which it passes. It immediately occurred that this principle might be applied in giving safety to the instrument: a new series of experiments was accordingly instituted, with an apparatus in which the amount of pressure on the gas could be accurately ascertained and regulated. By various modifications of the impelling power, it was proved that the gas, under moderate pressure, will return, in a state of ignition, through the smallest possible tubes, of whatever material, through the pores of cane, and even through those of Honduras mahogany; while, by increasing the pressure, the gas may be burned with safety at the end of a tube, one-eighth of an inch in diameter, and by still greater pressure is extinguished altogether.

The principle being thus established, it seemed necessary, merely to give due rapidity to the current of gas, to ensure safety to the reservoir; but that every slight diminution of its force, to which from various circumstances it might be exposed, would occasion a retrograde movement of the flame, and consequently cause the reservoir, or gasometer, to explode. After many fruitless attempts, the idea suggested itself to Mr. Gurney that he might make use of this retrograde movement of the flame to effect its own extinction, by allowing a partial explosion in a small chamber constructed for that purpose, and interposing between the chamber and the gasometer such a combination of tubes, or wire gauze, as would, agreeably to the principles already deduced, prevent the passage of inflamed gas into the reservoir, by taking advantage of the increased rapidity which it would acquire from the explosion in the chamber. On trial this contrivance appeared perfectly to accomplish its object; for the instant that the pressure was reduced, the flame passed back through the jet, exploded in the chamber, and was there extinguished: continuing the experiments, however, it was discovered, that when the jets exceeded a certain size they allowed the free escape outwards of the expanded gas and aqueous vapour, and thus greatly diminished the rapidity with which the remainder of the gas contained in the chamber was propelled through the interposed wire gauze; the consequence was, that the flame was communicated to the gasometer. To obviate this, however, merely required an increase of the mechanical force of the explosion, by enlarging the size of the chamber; and it was ascertained that, to ensure safety, the capacity of the chamber must be proportioned to the size of the jet and of the meshes of wire gauze. With these provisions, the apparatus has, by innumerable trials, been proved to be effectual; and even when acted on precisely under the same circumstances as those which allowed the explosion to pass even through the pores of dense wood, the flame has never receded beyond the safety chamber.

Thus assured of having obtained his object, Mr. Gurney would have remained satisfied; but considering how difficult it is to remove the general impression of hazard attending the use of the oxy-hydrogen blow-pipe, he has introduced into the construction of the instrument the additional precaution of a cistern of water between the jet and the bladder containing the gas.

The following references to the engravings, plates IV and V, will supply a complete description of the form and construction of the instrument.

a is the reservoir or gasometer, consisting of a small bladder, supported on a table *b*, and surmounted by a thin board *c*, which is strengthened by the ribs *d d*, and attached by slight threads to the four wires *e e e e* which pass freely through holes in the table *b* and are fastened at their lower extremities to the board *f f*, called the pressure board. This board is perforated in the centre, and the aperture is occupied by the upright rod *g g*, which guides it in its motion up and down. To this board the hand of the operator is applied for the purpose of compressing the gasometer and of causing the gas to escape at the jet *h*, the nature of the communication of which with the gasometer is explained in the section fig. 1, plate V, in which *a* is the lower part of the gasometer, attached to a brass neck in the cap over the cylindrical chamber *k*, of which a horizontal section is shown on a larger scale at fig. 2. This chamber, together with the tubes on each side of it, as far as the letters *z z*, is concealed in the table *b*, which has a slight concavity formed in its centre, to offer a more convenient resisting surface to the pressure of the bladder. The gas is driven in the direction marked by the arrows, till it passes into the curved pipe *l*, immersed in the cylindrical water-vessel *m*, through which it rises in bubbles. The water-vessel is closed by a cork *n*, so fitted, that in the event of an explosion taking place there, the cork would be thrown out and no farther consequences ensue. There is another curved pipe *o o*, running up into the cork *n*, which, for the present, it may be supposed does not exist, and that the gas finds its way immediately from the surface of the water to the chamber *p*; it then passes through about sixty layers of wire gauze *q* (having eighty meshes to the inch), next into the chamber *r*, thence through about twenty other layers of similar gauze *s*, into the chamber *t*, and lastly escapes at the jet *h*, where it is inflamed.

Having described the progress of the gas from the gasometer to the jet, it will best explain the nature of the contrivance for preventing any mischief arising from explosion, to trace the effect of an explosion backwards to the gasometer. As soon as the pressure on this last is sufficiently reduced, the flame at the jet recedes and inflames the gas in the chamber *t*, the mechanical force of which explosion is supposed adequate to prevent the passage of the flame through the wire gauze *s*, according to the principles before alluded to. Should it fail to do this, a second explosion takes place in the chamber *r*, the force of which acts on the second series of wire gauze layers *q*, and once more tends to extinguish the flame; which if it does not accomplish, the explosion is communicated to the gas over the water, and the cork is thrown out as already described. The top *c* surmounting the bladder, and the ribs *d d* which strengthen it are made of wood so thin, that in the event of their being thrown up by an explosion of the gasometer, the resistance of the air prevents them from rising to any considerable height and they fall to the ground perfectly harmless.

The gasometer can be replenished at pleasure by means of the transferring bladder *u*, plate IV, which communicates with the cylindrical chamber *k*, as shown in fig. 1, plate V. That communication is shut off by the spiral spring acting against the valve *v*, fig. 2, as soon as the pressure is withdrawn. The stop cocks *w w* cut off the connexion between the different parts of the apparatus when required. The purpose of the curved pipe *o o* is the following: it was found that the water in the vessel *n* was sometimes so violently agitated by the rapid passage of the gas through it, that it filled the safety chambers *r* and *t*,* and to prevent this, the curved pipe *o o* was added, and a deep cavity was made in the cork somewhat larger than the pipe. The lower surface of the cork is covered with a piece of leather, which embraces the pipe closely, and prevents both the water and gas from passing immediately into the cavity in the cork: that the gas however may find its way into the cavity, the cork does not descend close to the shoulders of the water-vessel, and two channels (see *x x*, fig. 3) are formed in its lower surface previous to covering it with leather. The lower edges of the cork are rounded or chamfered off, which gives the gas easy access to the channels, and thence to the cavity and to the pipe. In fig. 1, *y* is a screw which regulates the height of the water in the vessel.

Fig. 4 represents a jet, having at its angle a swivel joint, by which the flame may be directed either upwards, downwards, or laterally, at any angle. This jet is screwed immediately into the water-cistern, and the safety chambers are placed at the other end, as near as possible to the issue pipe. This construction is necessary in order to avoid explosion;

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* Another mode of preventing the influx of water into the safety chamber has been proposed; namely, to fill the cistern with oil instead of water; this, however, is highly objectionable, on account both of the combustibility of the oil, and of its comparatively viscid consistence, in consequence of which, when a full stream of gas is passing through, the bubbles become almost continuous, and an explosion in the upper part of the cistern is very liable to be communicated through the oil to the bladder or reservoir.

for if the safety chambers were placed at that end which is adjacent to the water-cistern, nearly the whole cavity of the jet would be in front of the first safety chamber, the consequence of which would be, when an explosion took place in this chamber, that the expanded vapour would pass so freely forwards as to be incapable of moving in the opposite direction with the rapidity necessary to extinguish the flame.

The dark parts shown in the engraving between the abutting shoulders at all the screwed joints, represent collars of leather. A variety of jets differing both in length and diameter are made and applied as the nature of the effect to be produced requires; but in all these jets the safety chambers must be placed as near as possible to the orifice for the issue of the gas. Fig. 4 represents one with a swivel joint, by which the flame can be directed perpendicularly upwards or downwards, laterally, or at any angle.

Fig. 5 describes a simple apparatus for collecting the products evolved during the decomposition of any substance by the blow-pipe. A is a slab of chalk, having a cavity in its upper surface, to receive the material to be acted on; the jet which is so formed as to throw the flame obliquely downwards, is introduced through the side of the slab of chalk, and is, together with the safety chambers, attached by a flexible tube B B to the water-vessel of the blow-pipe. The slab of chalk is ground on its upper surface, to fit a ground glass receiver, with a brass cap, stop-cock, and bladder, to collect the products of the decomposition.